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SANITARY LANDFILL DEMONSTRATION OF A GULLY RECLAMATION METHOD

U.S. ENVIRONMENTAL PROTECTION AGENCY

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SANITARY LANDFILL DEMONSTRATION OF A GULLY RECLAMATION METHOD

This Processing and Disposal Division Open-File Report (SW-37d.of) is the final report on solid waste management demonstration grant no. G06-EC-00011 as prepared by

DENNIS G. FENN, Sanitary Engineer

U.S. ENVIRONMENTAL PROTECTION AGENCY
1972

SUMMARY

In Sarpy County, Nebraska, a geographic location where badly eroded loess-mantled hills are common, a gully has been successfully utilized as a unique answer to the problem of solid waste disposal employing the sanitary landfill method of disposal. In addition, the benefit of reclaiming a gully for agricultural purposes was achieved.

In the conventional trench method of sanitary landfill soil is excavated forming trenches into which layers of solid waste and soil cover are alternately placed and a thicker surface cover applied at ground level. The distinguishing feature of operating a sanitary landfill in a gully is that the gully provides the trench, and only a minimum amount of excavation is necessary to obtain cover material.

The project has demonstrated the structural feasibility of this method. An earth dam, properly engineered for drainage control, was constructed at the lower end of the gully, and solid waste was landfilled behind this structure. To date, no further erosion has occurred in this previously scarred tract of land.

The demonstration project also indicated a favorable economic situation. During the fourteen months of operation, about 8,000 tons of solid waste were deposited at a rate of about 25 tons per day and for an operational cost of about $4.70 per ton (excluding $4.98 per ton site development costs). This cost compares favorably with similar size operations using conventional trench or area methods although this project has the added advantages of increased land values and acreage

for agricultural use, controlling soil erosion, providing a stable drainage outlet for adjacent land, and adding to the beauty of the countryside.

INTRODUCTION

Solid waste disposal into voided land or gullies has been practiced for many years in the form of dumps, as was the case in the Omaha metropolitan area. Little control was exercised over the operation of the dumps, and increasing public criticism was encountered. Large quantities of solid wastes were being unlawfully and extensively dumped throughout the countryside in roadside ditches and open waterways causing health hazards and flood control problems. In the fall of 1965 heavy rains washed out many of these dumps, forming dams of debris at bridge abutments which resulted in excessive flooding of lowland property. Damage from this flooding was estimated at $200,000.

Obviously, acceptable solid waste disposal practices were conspicuous by their absence, a situation of major concern to local leaders of the Papillion (Papio) Creek Watershed Improvement Program and the local governing boards. These groups recognized the need for technical and financial assistance to develop and institute an economical and environmentally acceptable method of solid waste disposal.

Aerial photographs were taken, and hundreds of growing gullies that had already eroded huge voids into the deep, windblown, silty soils were located. Experience with structural gully control methods indicated that the numerous gully problem areas could be acceptable for disposal of solid wastes. However, it was determined by a committee of local health, land, and water resources officials that there was a lack of reliable information and experience to publicly recommend and approve

gully-type sanitary landfill methods. Therefore, a pilot project was recommended to demonstrate the difference between a sanitary landfill and a dump, to collect sufficient data, and to provide needed specifications and standards for gully sanitary landfill operations. Because of its similar objectives and interest in gully and erosion control, the Sarpy Soil and Water Conservation District became the applicant for the Federal project.

OBJECTIVES, PREPARATIONS, AND DEVELOPMENT

A four and a half acre tree-lined gully site was selected for the demonstration sanitary landfill project (Figure 1). The main objectives of the project were to:

(1) Demonstrate to public officials, community residents, and landowners the acceptability of properly planned and operated sanitary landfills near the source of solid waste.

(2) Demonstrate that such a sanitary landfill can reclaim gullied land and provide a stable outlet for future runoff water, as well as be a part of a community-wide plan for solid waste disposal.

(3) Develop a practical guide for establishing future standards and regulations concerning sanitary landfill design and operation.

Acceptance of the project by public officials has been well demonstrated. Legal authority to issue permits and inspect private solid waste disposal sites has rested with the Sarpy County Board of Commissioners since as early as 1954. However, prior to initiation of the demonstration project the Board had not exercised this authority with respect to the dumps existing within their jurisdiction; neither had the Board appropriated local funds for solid waste disposal within the County. As a result of the demonstration project's success, the Board in 1968 appropriated $28,000 to provide for a second sanitary landfill (Site No. 2) upon completion of the demonstration project. Site No. 2 was operated near the demonstration landfill (Figure 2) and was completed in the spring of 1970. These funds, in addition to fees collected from commercial haulers using the sanitary landfill, have enabled the County to provide free disposal service for the public.

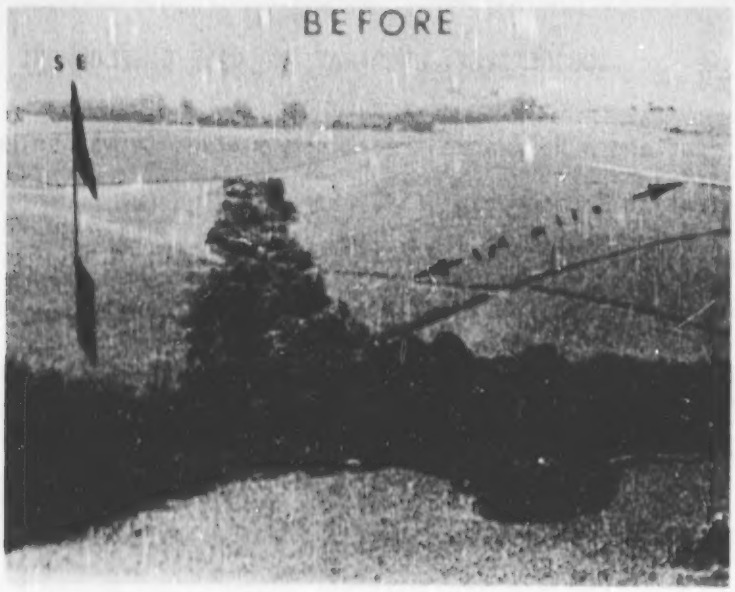

Figure 1. Tree-lined gully before sanitary landfilling started; upstream view.

Figure 2. Final two feet of cover being placed on completed fill; landfill site No. 2 at lower left.

The demonstration sanitary landfill also gained the acceptance of local residents. Public relations and timely informative meetings with the neighboring landowners of a proposed sanitary landfill site are extremely important and should be pursued as soon as preliminary site evaluations are complete. The two landowners of the demonstration project site were contacted by the project manager to determine their willingness to participate in the proposed sanitary landfill demonstration. As soon as the application for Federal demonstration grant assistance was approved, the neighboring landowners were contacted, and the three-year demonstration project was explained. Sufficient contacts were made and the project was so adequately explained that no one appeared at the Planning Board Hearing in opposition to the requested zoning change and special land-use permit. Temporary easement agreements were then signed with the landowners.

In this demonstration, the primary incentives for landowner cooperation were the benefits they would receive from reclaiming gullied land, control of the active gullies, and more convenient field crossings for farming operations. The property owners involved have stated their complete satisfaction with the demonstration project and gladly signed easements allowing the county to operate a second sanitary landfill in another gully on their property. Also, as a result of the successful nature of the demonstration project, County officials encountered little public opposition in obtaining land for subsequent operations. In May 1970, with the assistance of the Sarpy Soil and Water Conservation District, a 20-acre site in another part of the county was rented from

its owner and developed into a sanitary landfill operation. The gully reclamation method developed by the demonstration project is being utilized at this site.

The project had several land reclamation aspects. With proper compaction and a final cover of two feet of clean soil, gully sanitary landfill sites can be considered for agricultural or recreational uses, thereby increasing the value and productivity of previously unusable land. The 4.5 acres of previously unfarmable land are now covered with brome grass and corn. Corn production in this area can average about $50 per acre net income, thereby offering a potential increase in net income to the landowner of about $200 per year. Benefits will also be received from improved farming operations since tractors and implements can now cross the former gully, thereby affording more efficient field travel.

Construction of the sanitary landfill also prevented expansion of the gully and protected valuable adjacent land. Placement of the drop-inlet structure at the outlet of the gully controls 22 vertical feet of drop through the corrugated metal pipe spillway. The voiding of two acres of land by erosion that may have taken place during the next 25 years has been prevented. The estimated average annual benefit to property is $25 per acre.

The project provided a stable outlet for terraced crop land. The construction of the grade control structure and filling of the voided

gully raised the waterway flow line an average of 20 feet. This provides a stable outlet for the terraces and grassed waterway which had been constructed for the 40 acres of cropland above the dam. This improvement triples the life of the terraces and waterways designed to hold in place an estimated 600 tons of soil that may have eroded off the land each year. The conservation practices applied are expected to reduce the annual sediment yield from 20 tons per acre to five tons per acre. A frequently used value to estimate the benefits of eliminating clogging sediment from waterways and reservoirs is $1 per ton. Using this somewhat arbitrary value, the benefits to the property owner and the public for sediment reduction could exceed $600 per year.

The reclamation of unusable land increases the taxable property value in addition to putting more land into production. Since the land will be used for agricultural purposes, the taxable land value should increase from about $5 per acre to $275 per acre within five years. The amount of settlement, maintenance required, and productivity of the filled area will establish a more reliable estimate of the improved land value. Thus for the 4.5 acre demonstration site, the county could eventually realize an increase in tax receipts of about $1200 within five years.

The Sanitary Landfill Site. A four-acre, tree-lined gully site in the SW 1/4 of Section 5, Township 13, Range 13, Sarpy County, Nebraska, was selected. The site is located outside the city limits of Omaha and about one mile west of Offutt Air Base. The main gully and adjacent land is private property, the latter used for agricultural purposes. Approximately 40 acres of farm land drain into the gullied area.

The sanitary landfill site had several advantages in that it: 1) was centrally located, 2) was accessible by all-weather roads, 3) had easily excavated soil, 4) was near an adequate supply of well water and electric power, 5) was protected from unauthorized persons, and 6) was in need of filling and grade and drainage control.

The primary area served by this sanitary landfill was the Offutt Air Base-Capehart residential area with an estimated population of 8,000. However, because of its close proximity and easy accessibility, 30% of the residents and industry from the nearby communities of Papillion (4,500), LaVista (3,500), Bellevue (22,000), Ralston (3,600), and several newly developed subdivisions also utilized the site for waste disposal.

Surface soils in the area include loess, clay, silt, and sand alluvium. The loess, which is a yellow to buff-colored silty clay, mantles the hills and valley sides to depths ranging up to 80 feet. The upper portion of the loess from 1.5 to 2 feet, has been converted into a highly productive soil by the natural additions of organic matter. The depth to bedrock varies from 70 to 100 feet below the present ground surface. The formation of the bedrock is Dakota sandstone, a fine-grained, iron-oxide cemented, moderately hard sandstone.

The groundwater is 18 to 20 feet below the surface throughout the downstream area of the landfill site. A 14-inch diameter domestic well, approximately 90 feet deep, is located in this area. The quality of the water was originally unfit for drinking and was developed only as a water supply for fire protection uses.

The climate of Sarpy County is classified as subhumid. It is typical of the Great Plains region characterized by warm summers and cold, dry winters. Rapid weather changes are characteristic with extreme temperature variation, strong and gusty winds for short periods, and severe thunderstorm rainfall. The average annual temperature is 51° F. Temperature extremes range from -36 to 116° F and frost depths of 36 inches are common. Average annual precipitation is about 28 inches, about 75 percent of which occurs during the growing season--April through September. Historically, annual precipitation has varied from 13.6 inches to 48.9 inches. Snowfall averages about 28 inches per year.

Site Development and Operation. Experience with other sanitary landfill methods showed that proper specifications and supervision were needed, and that with good drainage and grade control methods, voided gully areas could provide adequate solid waste disposal area. Therefore, a drop-inlet structure (small dam with drop spillway--Figure 3) was designed to prevent material (refuse and/or soil) from moving downstream and to control the new waterway grade established by the final fill. The site was cleared and the dam was constructed across the channel and gullied area as shown in Figures 4, 5, and 6. Dam construction was of

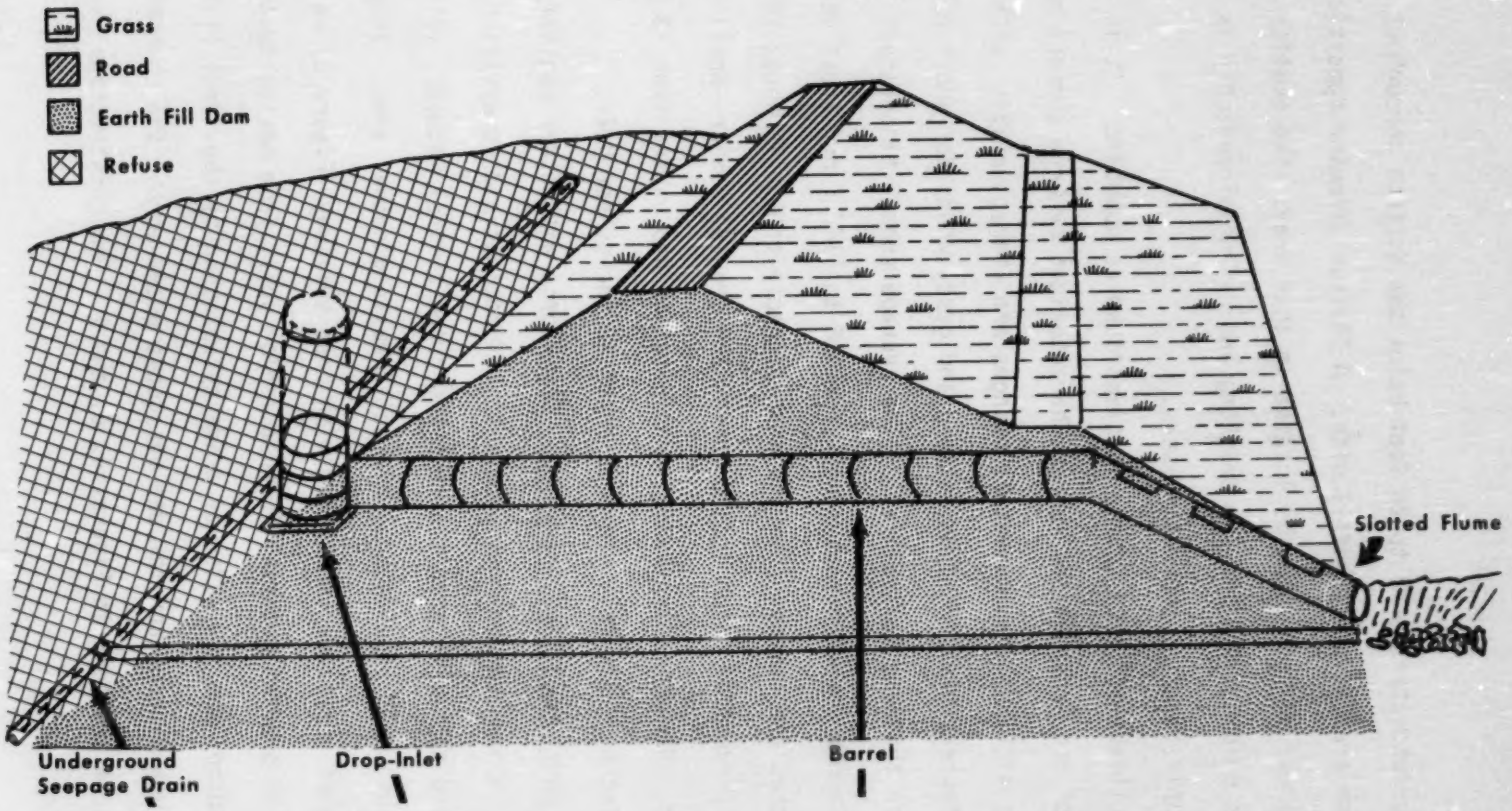

Figure 3. Cross-sectional view of the dam and drop-inlet structure at the foot of the landfilled gully.

Figure 4. Clearing and grubbing prior to construction.

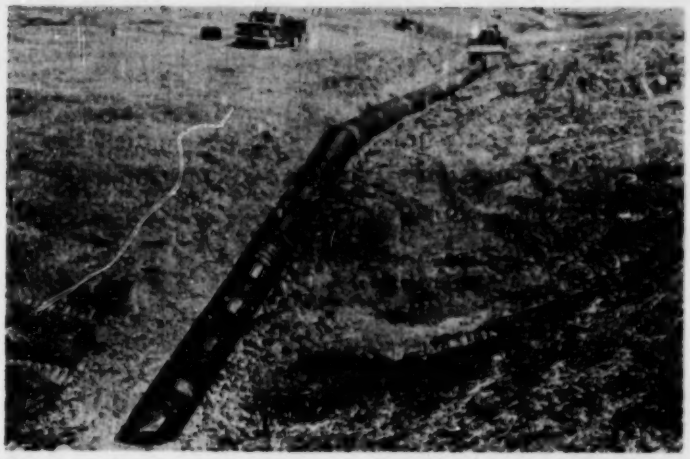

Figure 5. Earth-filled dam being constructed; a 30-inch corrugated metal pipe drop-inlet tube with slotted flume outlet is being installed.

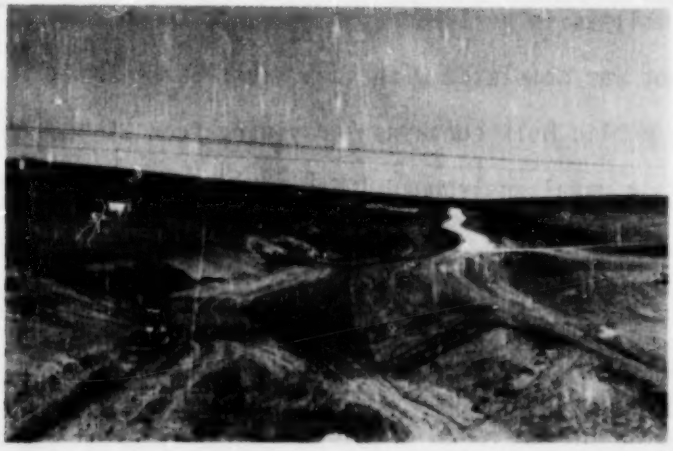

Figure 6. Start of landfill operations at upper end of gully; earth-filled dam under construction at lower left.

compacted earthfill. The drop spillway structure consists of a 42-inch C.M.P.[1] riser and 30-inch C.M.P. barrels with a slotted flume outlet. All metal components were asbestos-bonded and asphalt-coated for watertight construction. A 6-inch diameter C.M.P. slotted interceptor drain was installed for sampling underground seepage water from the sanitary landfill area. Periodic sampling was performed and to date there are no indications of leachate pollution in the seepage water.

Terrace diversion ditches, one on each side, were placed along the outer limits of the final fill grade to divert surface runoff from the 40-acre drainage area above and around the sanitary landfill area. The diversion ditches discharge into the 42-inch riser in the control structure through the dam.

The benefits obtained by combining these construction procedures with the sanitary landfill method were: 1) land reclamation, 2) soil conservation grade control, 3) countryside beautification, and 4) suitable solid waste disposal area. Such a sanitary landfill method has regional application in similar topography over a five-state area along the Missouri River as well as in gully areas throughout the nation.

The site development was completed with such features as the all-weather access road, a public bulk container providing free 24-hour service and a 20 X 8 foot metal scalehouse (Figure 7).

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[1] C.M.P. - Corrugated Metal Pipe

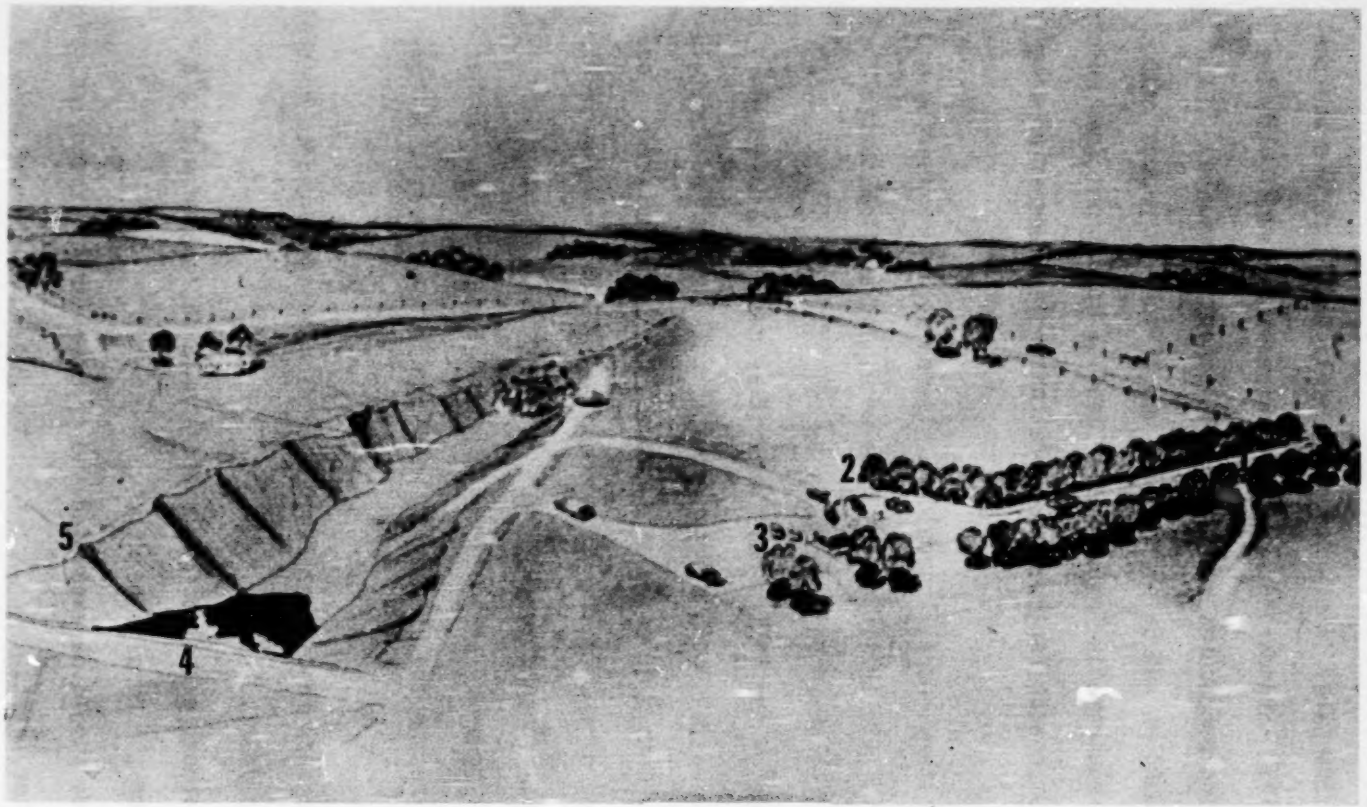

Figure 7. Artist's conception of operational site. Main features: 1. graveled entrance road; 2. free public disposal area; 3. scalehouse; 4. earth-fill dam; and 5. surface water diversion ditches.

The Sarpy Soil and Water Conservation District entered into an agreement with the Sarpy County Board of Commissioners to operate the sanitary landfill. Standards for operation were consistent with the highest operating procedures recognized throughout the state. The city of Omaha, and Douglas and Sarpy Counties had officially recognized standards and requirements for sanitary landfill operations from which the following standards for the demonstration project operation were derived:

1. The sanitary landfill should be planned as an engineering project with final fill grades, drainage, and erosion control facilities shown on a topographic map.
2. The face of the fill should be kept as narrow as possible.
3. Exposed waste should be covered with soil as soon as possible and six inches of cover soil placed over both the surface and the face of the fill to form a closed cell of the material from each daily deposition.
4. A final cover of at least 24 inches of clean soil should be maintained on the surface to be farmed after the fill is completed.
5. Movable snow fencing or other methods should be used to control blowing debris.
6. All-weather, gravel access roads should be located within a few yards of the deposit point.
7. Trenches should be excavated and cover material stockpiled prior to winter frosts.

8. Water under pressure should be available for fire-fighting and sanitation uses.

Site personnel consisted of a part-time manager from the Sarpy Soil and Water Conservation District and a full-time equipment operator. An office was established in the scale house, and the equipment operator was trained to maintain records on incoming solid waste. The equipment operator was also responsible for collecting fees from haulers; recording fees for monthly billing; as well as spreading, compacting, and covering the solid waste daily. The average daily volume of solid wastes was 85 cubic yards or about 25 tons; however, on peak days, the volume would frequently triple, thereby requiring another person to collect data and fees. Occasionally, additional labor was used to haul cover material, pick up litter, mow weeds, or sow grass cover seed on the completed areas. The Sarpy County Building Inspector inspected the operation periodically and filed a check sheet after each inspection.

Equipment at the site consisted of a TD-18 crawler dozer which performed all the operations of trenching, spreading, compacting, and covering very well. A D-8 crawler dozer and pull scraper were used to haul soil from the borrow area to be stockpiled as cover material for winter operations.

An eroded gully is usually narrow and quite shallow at the upper end. To increase the fill area and to obtain additional cover material, trenches six to seven feet deep were excavated across the original gully perpendicular to the gully axis.

In this demonstration project, a combination of the area and trench methods was used most successfully as depicted in Figures 8 and 9. At

Figure 8. New trench has been excavated to receive solid waste; area fill method is used to bring adjacent area to grade. Operator is spreading and compacting waste prior to applying cover material.

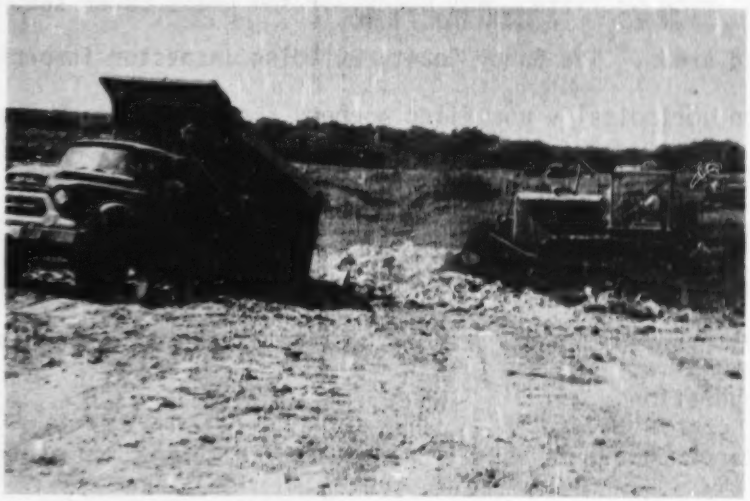

Figure 9. Solid waste being hauled over compacted fill areas to be spread, compacted, and covered in a newly excavated trench.

the upper end of the gully, an area-type fill was used. The refuse was spread in layers no more than two feet thick, and compacted by machine travel. This method was used for the first 150 feet of operation. Each succeeding 50- to 60-foot section down the gully was started with a trench excavated perpendicular to the original gully axis. This increased the gully capacity and provided 75% of the cover soil. After the trench was dug, the haulers were directed to dump at the end of the trench where cover material was stockpiled. The filling progressed across the gully with the filled portions serving as an access road to the working face. This method seemed to allow additional compaction as a result of the truck traffic on the refuse. In addition, the working face was kept small, exposing less refuse to wind and rain.

This demonstration indicated that the combination of methods used required more operator skill and judgment than at sites using conventional methods. Equipment operators of varying skill were used at the site, and the quality of the operation was less when inexperienced operators were employed.

Due to indiscriminate dumping along county roads and off bridges, it was decided to also demonstrate a public disposal station that would be free and open 24 hours a day. The station was designed for passenger cars and weekend (non-commercial) traffic and was constructed immediately to the west of the entrance road. This site was easily accessible to the public and afforded the site operator close observation. The area was fenced and rocked to provide all-weather controlled access.

Two Dempster metal top-loading containers were placed so that the tops were at ground level and against a retaining wall. Placing the container tops at ground level provided easy access for residents and facilitated maintenance of the area. The containers were the type that can be picked up with a special truck, weighed and then emptied into the fill. During the first few weeks of operation, the containers were adequate; however, as the volume increased the need for additional containers became evident. A three-month traffic study using a traffic counter placed across the entrance to the public disposal site showed an average use of 500 vehicles per month for the period May through July 1967. The need for such a public refuse disposal area has been accepted as highly desirable in this area; however, the relatively low cost of the operation determined the feasibility of providing this service without charge to the public. The primary difficulty in providing this facility was the danger of fires resulting from hot refuse being placed into the containers. Fire protection and fire-proof materials should be considered for such installations.

The greatest problems encountered in the sanitary landfill operation were the control of blowing debris and the disposal of tree limbs. The natural funnel effect of the gully makes wind control facilities a must. Snow fence or slot cribing were used to control blowing paper. A barrier three tiers high was constructed at the south end of the fill and a single fence was placed on the east side. It was found that vertical fences allowed wind-blown debris to strike the fence and slide up over the top of the fence. Therefore, the fencing was installed with the top

slanted inward to catch blowing debris. On the west side of the fill area a "living fence" consisting of Sudex, a tall, sturdy sorghum plant, was used. The Sudex was planted close together so as to comprise a dense concentration of stalks and foliage. This was found to be highly desirable where a permanent installation is possible because the plant remains relatively erect in high winds and helps to restrict the blowing of paper. For best results Sudex should be planted in a belt about eight feet wide with a grain drill.

Although not used at this site, portable fences built with wire mesh on steel frames would also be beneficial. These could be moved with equipment and save a great deal of labor. Regardless of which method one chooses, this project showed that a gully lying at right angles to the prevailing winds would provide some wind protection and make it easier to control the blowing of paper.

In the past, trees have been a small part of the total solid waste of a community. However, because of the Dutch Elm disease in the area the large quantities of trees received at the demonstration site became an early problem. Although it was possible to landfill trees in the demonstration site, this presented the equipment operator with difficulties in spreading, compacting, and covering the solid waste thus substantially increasing the cost of operation at the site. Therefore, the recommendation was made and approved that a companion rubble-fill site for trees be established in a nearby gully site to the northeast. This was operated on a weekly spread and cover schedule, and the sanitary landfill equipment and operator were used to operate the rubble-fill

site also. Although this procedure did make the main gully operation more efficient, it did have the drawbacks of being an eyesore, a fire hazard and a potential harborage for rodents. This problem certainly deserves additional consideration.

The economics experienced at the site were favorable for this size operation (25 tons/day). The unit costs and revenues encountered were:

Site Development Cost	-	$4.98/ton
Operational Cost	-	$4.71/ton
Revenue	-	$2.45/ton
Net Disposal Costs	-	$7.23/ton

The site, operated from April 1967 to June 1968, disposed of 8,000 tons of refuse. At first glance, the above costs may seem high, but consideration must be given to the extra benefits which resulted from the sanitary landfill including:

- Increased farm acreage. Each additional acre of corn offers the farmer up to $50 annual increase in net income.

- Increase taxable land values. Each acre reclaimed for agricultural uses would be increased in value by about $275 in five years.

- Effective erosion control at the site. This would benefit the site about $25 per acre annually.

- Effective flood control. It is estimated that each ton of sediment washed from the land into the waterways results in about one dollar of flood damage. This site could potentially save the county $600 annually from reduced flood damages.

- The closing of many open dumps. This, of course, is a tremendous asset to the health conditions in the area and is impossible to quantify with a dollar value.

Therefore, in time the seemingly high costs of this sanitary landfill will be easily offset by the savings from the beneficial effects of this project and it will surely prove itself as a very worthwhile investment.

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